Influence of Heat Flux Configuration on the Temperature Distribution at the Tool-Chip Interface

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Abstract

This paper analyzes quantitatively heat transfer problem in the cutting tool in a steady –state orthogonal cutting when using uncoated carbide tools and the AISI 304 stainless steel as a work material. In particular, Finite Difference Approach (FDA) is applied to predict the changes of temperature distribution and both average and maximum temperatures at the tool-chip interface resulting from differentiating the heat flux configuration. Moreover, some possible measuring and computing errors, as for example ±5%, ±10% and ±15% variations of the tool-chip contact length and the intensity of heat source in relation to the experimentally obtained values were considered in simulations. Basically, uniformly distributed plane, symmetrical and asymmetrical triangular, and symmetrical and asymmetrical trapezoid-type heat flux configurations were taken into account. It was found that the assumption of an asymmetrical trapezoidal shape of heat flux configuration provide the simulated results closer to the experimental data. On the other hand, the simulations confirmed a distinct influence of the heat flux intensity and quite marginal influence of the contact length on the interface temperatures. Additionally, the paper provides unique isothermal maps for temperature distribution at cutting speeds between 120-165 m/min and the materials tested. It can be concluded that the FDA-based modelling of the tool-chip interface temperature distribution is a very robust computing method and allows establishing the variations of heat transfer along the interface.